

WHAT IS CLAIMED IS:

- 1 1. A method for manufacturing a vacuum or hermetically
2 packaged micromachined or MEMS device having at least one substantially vertical
3 feedthrough, the method comprising:
4 providing a micromachined or MEMS device fabricated on a first side
5 of a substrate and located within a vacuum or hermetic cavity;
6 forming at least one hole completely through the substrate between
7 first and second sides of the substrate after the step of providing; and
8 forming a path of electrically conductive material connecting the
9 micromachined or MEMS device and the second side of the substrate through the
10 at least one hole to form the at least one substantially vertical feedthrough.
- 1 2. The method as claimed in claim 1, wherein the substrate is a
2 glass substrate.
- 1 3. The method as claimed in claim 1, wherein vacuum or
2 hermetic cavity is at least partially defined by a capsule connected to the substrate
3 at a bonding area.
- 1 4. The method as claimed in claim 1, wherein the micromachined
2 or MEMS device includes at least one microstructure.
- 1 5. The method as claimed in claim 4, wherein the at least one
2 microstructure includes a doped-semiconductor or metal microstructure.
- 1 6. The method as claimed in claim 1, further comprising forming
2 a plurality of electrical leads on the first side of the substrate in communication with
3 the micromachined or MEMS device.
- 1 7. The method as claimed in claim 1, wherein the step of
2 providing may include the step of bonding a capsule to the substrate to form the

3 vacuum or hermetic cavity and wherein the step of forming may include the step of
4 partially forming the at least one hole from the first side before the step of bonding.

1 8. The method as claimed in claim 1, wherein the step of
2 forming the at least one hole includes the step of etching the substrate at the second
3 side of the substrate.

1 9. The method as claimed in claim 3, wherein the step of
2 forming the path includes the step of depositing a layer of electrically conductive
3 material on the second side of the substrate and in the at least one hole.

1 10. The method as claimed in claim 9, further comprising placing
2 a solder ball or paste in the at least one hole on the layer of electrically conductive
3 material.

1 11. The method as claimed in claim 9, further comprising bonding
2 a wire to the layer of electrically conductive material.

1 12. The method as claimed in claim 9, wherein the layer is
2 deposited in the bonding area on the second side and wherein the method further
3 comprises placing a solder ball or paste on the layer of electrically conductive
4 material at the bonding area.

1 13. The method as claimed in claim 1, further comprising
2 removing material from the second side of the substrate to thin the substrate before
3 the step of forming the at least one hole.

1 14. The method as claimed in claim 3, wherein the capsule is
2 anodically bonded at the bonding area.

1 15. The method as claimed in claim 3, wherein the capsule is
2 eutectically or solder bonded at the bonding area.

1 16. A method for manufacturing a vacuum or hermetically
2 packaged micromachined or MEMS device, the method comprising:
3 providing a wafer and a substrate having first and second sides;
4 partially forming at least one hole in the first side of the substrate;
5 bonding the wafer to the substrate to obtain a device substrate after
6 the step of partially forming;
7 fabricating a micromachined or MEMS device from the wafer after
8 the step of bonding;
9 positioning a capsule having a concave surface on the device substrate
10 over the micromachined or MEMS device;
11 bonding the capsule to the device substrate to form a vacuum or
12 hermetic cavity enclosing the micromachined or MEMS device and to form a
13 bonding area which provides a hermetic seal around the vacuum or hermetic cavity;
14 thinning the substrate down;
15 finish forming at least one hole completely through the substrate
16 between the first and second sides after the step of thinning; and
17 forming a path of electrically conductive material connecting the
18 micromachined or MEMS device and the second side of the substrate through the
19 at least one hole.

1 17. The method as claimed in claim 16, wherein the substrate is
2 a glass substrate.

1 18. The method as claimed in claim 16, wherein the capsule is a
2 silicon or glass capsule.

1 19. The method as claimed in claim 16, wherein the
2 micromachined or MEMS device includes at least one microstructure.

1 20. The method as claimed in claim 19, wherein the at least one
2 microstructure includes a doped-semiconductor or metal microstructure.

1 21. The method as claimed in claim 16, further comprising
2 forming a plurality of electrical leads on the first side of the substrate in
3 communication with the micromachined or MEMS device.

1 22. The method as claimed in claim 16, wherein the step of
2 partially forming the at least one hole includes the step of removing material from
3 the substrate to form at least one recess in the first side of the substrate before the
4 step of bonding the wafer to the substrate.

1 23. The method as claimed in claim 16, wherein the step of
2 thinning includes the step of etching the substrate at the second side of the substrate
3 after the step of bonding the capsule to the device substrate.

1 24. The method as claimed in claim 16, wherein the step of
2 forming the path includes the step of depositing a layer of electrically conductive
3 material on the second side of the substrate and in the at least one hole.

1 25. The method as claimed in claim 24, further comprising
2 placing a solder ball or paste that can be heated to form a solder ball in the at least
3 one hole on the layer of electrically conductive material.

1 26. The method as claimed in claim 24, further comprising
2 bonding a wire to the layer of electrically conductive material.

1 27. The method as claimed in claim 24, wherein the layer is
2 deposited at the bonding area on the second side and wherein the method further
3 comprises placing a solder ball or paste on the layer of electrically conductive
4 material at the bonding area.

1 28. The method as claimed in claim 16, wherein the step of
2 thinning includes the step of removing material from the second side of the substrate
3 to thin the substrate after the step of bonding the capsule to the device substrate and
4 before the step of finish forming.

1 29. The method as claimed in claim 16, wherein the step of
2 bonding the capsule to the device substrate includes the step of anodically bonding
3 the capsule to the substrate.

1 30. The method as claimed in claim 16, wherein the step of
2 bonding the capsule to the device substrate includes the step of eutectically or solder
3 bonding the capsule to a peripheral portion of the semiconductor device to minimize
4 outgasing into the vacuum or hermetic cavity.

1 31. A vacuum or hermetic packaged micromachined or MEMS
2 device manufactured in accordance with the steps of claim 16.

1 32. The device as claimed in claim 31, wherein the substrate is
2 a glass substrate.

1 33. The device as claimed in claim 31, wherein the capsule is a
2 silicon or glass capsule.

1 34. The device as claimed in claim 31, wherein the
2 micromachined or MEMS device includes at least one microstructure.

1 35. The device as claimed in claim 34, wherein the at least one
2 microstructure includes a doped-semiconductor or metal microstructure.

1 36. The device as claimed in claim 31, further comprising a
2 plurality of electrical leads on the first side of the substrate in communication with
3 the micromachined or MEMS device.

1 37. The device as claimed in claim 31, wherein the path includes
2 a layer of electrically conductive material in the second side of the device substrate
3 and in the at least one hole.

1 38. The device as claimed in claim 37, further comprising a solder
2 ball positioned in the at least one hole on the layer.

1 39. The device as claimed in claim 37, wherein the layer is
2 deposited in the bonding area on the second side and wherein the device further
3 comprises a solder ball positioned on the layer in the bonding area.

1 40. The device as claimed in claim 31 wherein the micromachined
2 or MEMS device includes at least one MEMS device.